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Estimates of the Impact of Releases at Dworshak and Brownlee
on Water Temperature in the Lower Snake River

Introduction

Several scenarios involving various flow release schedules at Brownlee and Dworshak dams were analyzed to determine their impact on water temperatures in the Lower Snake River in the State of Washington. For purposes of evaluating the benefits to salmon migration in the Snake River during the summer of 2000, 16 scenarios were developed by the National Marine Fisheries Service and five by the Nez Perce Tribe and the State of Idaho. It was necessary to make certain assumptions regarding flow and weather conditions in the segments of the Snake River included in the analysis. These assumptions were developed from recommendations transmitted to EPA Region 10 by Paul Wagner of the National Marine Fisheries Service (NMFS).

Methods

Water temperatures in the Snake River from its confluence with the Grande Ronde (River Mile 168.0) to its confluence with the Columbia River near Pasco (River Mile 0.0) and water temperatures in the Clearwater River from its confluence with the North Fork (River Mile 41.0) to its confluence with the Snake near Lewiston (River Mile 0.0) were simulated with the one-dimensional thermal energy budget model described by Yearsley (1999). The model requires as input the river geometry and hydraulic characteristics in addition to system hydrology and meteorology. River geometry and hydraulic characteristics were assumed to be the same as that used for the scenario in Yearsley (1999) used to describe the Columbia and Snake rivers with all hydroelectric facilities in place. Based on recommendations transmitted to EPA Region 10 by Paul Wagner of NMFS, 1998 was selected as the year for which meteorology, input water temperatures and river hydrology would be appropriate. Weather data from the Surface Airways CD for Lewiston, Idaho were used to develop the thermal energy budget.

A simulation of actual conditions was conducted to provide a means of assessing model acceptability. The results are presented in Figures 1-4, in which simulated daily-averaged water temperatures at Lower Granite Dam, Little Goose Dam, Lower Monumental Dam and Ice Harbor Dam are compared to observed temperatures. Observed temperatures from the tailraces of all four dams are used in the comparisons. In addition, forebay temperatures at Lower Granite are also provided to illustrate the magnitude of vertical stratification in that reservoir.

The flow for Brownlee and Dworshak specified for each all the scenarios are given in Tables 1 and 2. Release temperatures from Dworshak from the first week of July to the second week of September were assumed to be 8.33 deg C.

Table 1. Flow scenarios for releases from Brownlee and Dworshak dams proposed by NMFS (flows in kcfs).

Scenario:		1		2		3		4		5	
		DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN
July	Week	1.0	25.0	20.0	30.0	1.0	30.0	1.0	29.0	1.0	30.0
	Week	1.0	25.0	20.0	30.0	1.0	30.0	1.0	24.0	12.0	30.0
	Week	12.0	25.0	20.0	30.0	10.0	25.0	14.0	22.0	20.0	30.0
	Week	12.0	25.0	20.0	17.0	10.0	20.0	19.0	19.0	15.0	13.0
August	Week	12.0	23.0	12.0	15.0	20.0	16.0	17.0	20.0	12.0	13.0
	Week	12.0	13.0	1.0	13.0	20.0	13.0	13.0	16.0	12.0	13.0
	Week	12.0	12.0	1.0	12.0	12.0	12.0	14.0	15.0	12.0	13.0
	Week	12.0	12.0	1.0	12.0	10.0	12.0	12.0	12.0	8.0	13.0
Septe	Week	12.0	12.0	1.0	12.0	6.0	12.0	3.0	12.0	1.0	13.0
	Week	12.0	12.0	1.0	12.0	6.0	12.0	1.0	12.0	1.0	12.0

Table 1(continued). Flow scenarios for releases from Brownlee and Dworshak dams proposed by NMFS (flows in kcfs).

		6		7		8		9		10	
		DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN
July	Week	1.0	26.0	20.0	26.0	1.0	26.0	1.0	26.0	1.0	26.0
	Week	1.0	26.0	20.0	26.0	1.0	26.0	1.0	26.0	12.0	26.0
	Week	12.0	26.0	20.0	26.0	10.0	26.0	14.0	26.0	20.0	26.0
	Week	12.0	26.0	20.0	26.0	10.0	26.0	19.0	26.0	15.0	26.0
August	Week	12.0	13.0	12.0	13.0	20.0	13.0	17.0	13.0	12.0	13.0
	Week	12.0	13.0	1.0	13.0	20.0	13.0	13.0	13.0	12.0	13.0
	Week	12.0	13.0	1.0	13.0	12.0	13.0	14.0	13.0	12.0	13.0
	Week	12.0	12.0	1.0	12.0	10.0	12.0	12.0	12.0	8.0	12.0
Septe	Week	12.0	12.0	1.0	12.0	6.0	12.0	3.0	12.0	1.0	12.0
	Week	12.0	12.0	1.0	12.0	6.0	12.0	1.0	12.0	1.0	12.0

Table 1 (continued). Flow scenarios for releases from Brownlee and Dworshak dams proposed by NMFS (flows in kcfs).

		11		12		13		14		15	
		DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN
July	Week	3.0	26.0	10.0	26.0	3.0	26.0	3.0	16.	10.0	16.0
	Week	3.0	26.0	14.0	26.0	3.0	26.0	3.0	20.0	14.0	20
	Week	2.0	26.0	14.0	26.0	2.0	26.0	2.0	20.0	14.0	20.0
	Week	3.0	26.0	14.0	26.0	1.5	26.0	3.0	15.0	14.0	15.0
August	Week	14.0	13.0	12.0	13.0	1.5	13.0	14.0	14.0	12.0	14.0
	Week	14.0	13.0	12.0	13.0	1.5	13.0	14.0	14.0	12.0	14.0
	Week	14.0	13.0	12.0	13.0	1.5	13.0	14.0	14.0	12.0	14.0
	Week	14.0	12.0	4.0	12.0	1.5	12.0	14.0	14.0	4.0	14.0
Septe	Week	14.0	12.0	1.5	12.0	1.5	12.0	14.0	14.0	1.5	14.0
	Week	14.0	12.0	1.5	12.0	1.5	12.0	14.0	12.0	1.5	12.0

Table 1 (continued). Flow scenarios for releases from Brownlee and Dworshak dams proposed by NMFS (flows in kcfs).

		16	
		DWR	BRN
July	Week	1.0	16.0
	Week	1.0	20.0
	Week	14.0	20.0
	Week	19.0	15.0
August	Week	17.0	14.0
	Week	13.0	14.0
	Week	14.0	14.0
	Week	12.0	14.0
Septe	Week	3.0	14.0
	Week	1.5	12.0

Table 2. Flow scenarios for releases from Brownlee and Dworshak dams proposed by Nez Perce Tribe and the State of Idaho (flows in kcfs).

Scenario:		NPT_I_1		NPT_I_2		ID-NPT		Alt #1		FED-TMT	
		DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN	DWR	BRN
July	Week	5.0	18.0	5.0	18.0	4.0	18.0	4.4	18.0	4.4	18.0
	Week	3.0	16.0	3.0	16.0	3.4	16.0	6.0	16.0	14.0	16.0
	Week	2.2	15.0	7.0	15.0	2.0	15.0	7.0	15.0	14.0	15.0
	Week	2.0	16.0	11.0	16.0	1.6	16.0	10.0	16.0	14.0	16.0
August	Week	12.0	13.0	13.0	13.0	12.0	13.0	12.0	13.0	14.0	13.0
	Week	14.0	13.0	14.0	13.0	14.0	13.0	14.0	13.0	14.0	13.0
	Week	14.0	13.0	14.0	13.0	14.0	13.0	14.0	13.0	14.0	13.0
	Week	14.0	13.0	14.0	13.0	14.0	13.0	12.0	13.0	14.0	13.0
Septe	Week	14.0	13.0	11.0	13.0	14.0	13.0	10.0	13.0	3.0	13.0
	Week	12.0	13.0	8.0	13.0	12.0	13.0	8.0	13.0	1.5	13.0

Table 3. Environmental metrics of the various scenarios at Lower Granite Dam

Scenario	Max Temp °C	Days> 20 °C	First Day ≤20 °C	Last Day ≤20 °C	Flow	Waiver Required?
1	22.2	35	07/10	09/22		no
2	23.0	44	08/08	09/22		yes - 4
3	22.8	32	07/09	09/22		yes - 2
4	22.7	34	07/09	09/22		yes - 2
5	22.5	26	07/09	09/22		yes - 2
6	22.1	30	07/10	09/22		no
7	23.1	42	08/11	09/22		yes - 4
8	22.7	31	07/10	09/22		yes - 2
9	22.1	28	07/10	09/22		yes - 2
10	22.5	28	07/10	09/22		yes - 2
11	23.5	28	07/11	09/22		no
12	22.0	33	07/25	09/22		no
13	23.8	74	07/11	09/22		no
14	23.5	29	07/10	08/06		no
15	22.4	30	07/21	09/22		no
16	22.8	32	07/09	09/22		yes - 2
NPT_I_1	23.2	25	07/12	08/06		no
NPT_I_2	22.3	23	07/12	08/04		no
ID-NPT	23.3	27	07/11	08/06		no
Alt #1	22.0	23	07/11	08/04		no
Fed-TMT	22.2	27	07/11	10/01		no

Waiver estimated to be needed if Dworshak flow is over 14.

Table 4. Environmental metrics of the various scenarios at Little Goose Dam

Scenario	Max Temp °C	Days> 20 °C	First Day ≤20 °C	Last Day ≤20 °C	Flow	Waiver Required?
1	23.1	43	07/12	08/25		no
2	23.4	63	07/24	10/01		yes - 4
3	23.5	46	07/11	09/26		yes - 2
4	23.1	53	07/11	10/01		yes - 2
5	22.6	62	07/13	10/01		yes - 2
6	23.2	44	07/12	08/25		no
7	23.4	64	07/22	10/01		yes - 4
8	23.3	45	07/12	09/26		yes - 2
9	23.5	45	07/12	10/01		yes - 2
10	22.6	66	07/11	10/01		yes - 2
11	23.9	41	07/12	08/21		no
12	22.5	64	07/16	10/01		no
13	24.2	82	07/12	10/01		no
14	24.2	40	07/12	08/20		no
15	22.6	65	07/16	10/01		no
16	23.5	44	07/13	10/01		yes - 2
NPT_I_1	23.8	40	07/13	08/21		no
NPT_I_2	23.1	40	07/13	09/24		no
ID-NPT	23.9	41	07/11	08/20		no
Alt #1	22.7	43	07/11	09/15		no
Fed-TMT	22.9	36	07/13	10/06		no

Waiver estimated to be needed if Dworshak flow is over 14.

Table 5 Environmental metrics of the various scenarios at Lower Monumental

Scenario	Max Temp °C	Days> 20 °C	First Day >20 °C	Last Day >20 °C	Flow	Waiver Required?
1	24.1	56	07/10	09/11		no
2	23.7	75	07/22	10/04		yes - 4
3	24.1	58	07/11	10/01		yes - 2
4	24.0	70	07/13	10/04		yes - 2
5	22.4	86	07/11	10/04		yes - 2
6	23.8	59	07/10	09/11		no
7	23.6	73	07/22	10/04		yes - 4
8	23.8	57	07/10	10/01		yes - 2
9	23.9	69	07/10	10/04		yes - 2
10	22.7	85	07/10	10/04		yes - 2
11	24.1	45	07/14	09/03		no
12	22.3	82	07/14	10/04		no
13	24.6	83	07/14	10/04		no
14	24.1	46	07/11	09/02		no
15	22.5	82	07/10	10/04		no
16	23.9	71	07/11	10/04		yes - 2
NPT_I_1	24.3	44	07/15	08/29		no
NPT_I_2	23.6	46	07/15	09/22		no
ID-NPT	24.6	46	07/11	09/02		no
Alt #1	23.4	53	07/11	09/22		no
Fed-TMT	23.6	78	07/15	10/01		no

Waiver estimated to be needed if Dworshak flow is over 14.

Table 6. Environmental metrics of the various scenarios at Ice Harbor

Scenario	Max Temp °C	Days> 20 °C	First Day >20 °C	Last Day >20 °C	Flow	Waiver Required?
1	24.1	74	07/10	09/26		no
2	23.9	78	07/20	10/05		yes - 4
3	24.2	79	07/11	09/28		yes - 2
4	24.1	79	07/11	10/05		yes - 2
5	22.7	84	07/11	10/05		yes - 2
6	24.4	73	07/10	09/26		no
7	23.7	82	07/12	10/05		yes - 4
8	24.2	79	07/10	09/28		yes - 2
9	24.1	79	07/10	10/05		yes - 2
10	22.8	82	07/10	10/05		yes - 2
11	24.6	72	07/10	09/20		no
12	22.8	83	07/09	10/05		no
13	24.6	87	07/10	10/05		no
14	24.4	72	07/09	09/19		no
15	23.1	86	07/10	10/05		no
16	24.4	83	07/09	10/04		yes - 2
NPT_I_1	24.3	66	07/11	09/17		no
NPT_I_2	24.0	72	07/11	09/30		no
ID-NPT	24.4	72	07/09	09/26		no
Alt #1	24.1	80	07/09	09/30		no
Fed-TMT	24.2	83	07/11	10/03		no

Waiver estimated to be needed if Dworshak flow is over 14.

Results

The results of the simulations are shown in Figures 5-25. Tables 3-6 show the values of key parameters that may be useful in optimizing environmental conditions in the Clearwater and Snake rivers.

References

Yearsley, J.R. 1999. Columbia River Temperature Assessment: Simulation Methods. EPA Region 10, Seattle, Washington. 74 pp. + Appendices